

ASSESSING THE EFFECT OF SPACEFLIGHT ON THE PROPENSITY FOR ASTRONAUTS TO DEVELOP DISK HERNIATION

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BACKGROUND

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A previous study [1] reported the instantaneous risk of developing a Herniated Nucleus Pulposus (HNP) was higher in astronauts who had flown at least one mission, as compared with those in the corps who had not yet flown. However, the study only analyzed time to HNP after the first mission (if any) and did not account for the possible effects of multiple missions. While many HNPs occurred well into astronauts' careers or in some cases years after retirement, the higher incidence of HNPs relatively soon after completion of space missions appears to indicate that spaceflight may lead to an increased risk of HNP. The purpose of this study was to support the Human System Risk Boards assessment of back pain, assess the risk of injury due to dynamic loads, and update the dataset analyzed which contained data through December 31, 2006.

METHODS

Data was queried from the electronic medical record and provided by the Lifetime Surveillance of Astronaut Health. The data included all 330 United States astronauts from the beginning of the United States Space Program through February 2014. Cases were confirmed by Magnetic Resonance Imaging, Computerized Tomography, Myelography, operative findings, or through clinical confirmation with a neurologist or neurosurgeon. In this analysis, astronauts who were selected with an HNP or had an HNP diagnosis prior to their first flight were excluded. The statistical challenges in using the available data to separate effects of spaceflight from those associated with general astronaut training and lifestyle on propensity to develop HNPs are many. The basic outcome is date of first reported HNP (if any), which at best is only an approximation to the actual time of occurrence. To properly analyze this data with a survival analysis model, one must also know the "exposure" time – i.e. how long each astronaut has been at risk for developing an HNP. If an HNP is reported soon after a mission, is it mission caused or general? If the former, exposure time should be counted from the time of landing (we assume the risk of HNP is zero during a mission). If the latter, exposure time should be counted from the time of selection; however we can't directly know which one to use. In our analysis we take both of these possibilities into account with a competing risks model, wherein two distinct stochastic processes are going on: T_G = time to HNP (general) and T_S = time to HNP (spaceflight). Under this type of model, whichever of these occurs first is what we observe; in other words we don't observe T_G or T_S , only $\min(T_G, T_S)$. Here, we parameterized the model in terms of separate Weibull hazard functions for each process and estimated all parameters using maximum likelihood. In addition, we allowed for a "cured fraction" – i.e. the possibility that some astronauts may never develop an HNP.

RESULTS

Results will include a depiction of the competing hazard functions as well as a probability curve for the relative likelihood that an HNP reported at a given time after a mission is actually mission caused. Other factors, such as dwell time in microgravity and vehicle landing environment will be explored. An overall assessment as to whether spaceflight truly exacerbates HNP risk will be made.

REFERENCES

[1] Johnston, S. L., Campbell, M. R., Scheuring, R., and Feiveson, A. H (2010). Risk of Herniated Nucleus Pulposus among U.S. Astronauts. *Aviat Space Environ Med* 81, 566-74.